Fall 1992

South Dakota Farm and Home Research

South Dakota State University

South Dakota Farm & Home RESEARCH

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Volume 43, number 3, fall 1992

The year of biostress

Contents

About the Cover
The volatile weather patterns of South Dakota create biostresses on plants, animals, and people. In recent years drought has been the most serious weather related biostress factor in South Dakota. In 1992, nature shuffled the cards again and added torrential rains and flooding. Pictured is the Vince and Bobbie Parker farm near Clear Lake, where one night in June, nine inches of rain fell, pushing streams out of their banks and into farm yards.

photo: Emery Tschetter

South Dakota Farm & Home
RESEARCH

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Director's Comments

Bright spots in 'the year of biostress'

R. A. Moore

It's been a hard year, a year of biostress—late frosts, late harvests, hail, drought, flood. And now, as fall winds down, there are still more stresses ahead. Will the feed last until pastures green up again? Will it be a heavy winter? Are the kids all right down at college?

My work is about as far removed from teaching as you can get and still be associated with SDSU. But I can tell you about bright spots in this year of biostress—the young people that fill the classrooms, labs, and, yes, the parking lots at SDSU. Some of them are experiencing stress—away from home, finding careers, meeting the expectations of their professors. But, by and large, they handle it well; South Dakota young people are among the best in the country, as employers tell us when they come to campus to recruit. Naturally, these employers are looking for well trained graduates; but equally they are looking for "work ethic," which they find at SDSU much more often than in other parts of the country. "Work ethic" starts at home and is learned from you.

Many of our scientists in the Experiment Station teach classes and, like me, are energized by associating with your sons and daughters. We often use the word synergism; it means that two events are better together than either is separately. The benefits of researcher/teacher/student contacts flow both ways.

We employ students on our research projects, and they are good help. Again, the association of researcher and student is mutually beneficial. Next year, when the Northern Plains Biostress Lab here on campus is occupied, we hope to hire more help; with their nimble hands and quick understanding of things technical, students are good workers.

They may wonder at first why we named the building the "Biostress" Lab when, to these mechanically oriented young people, it looks more like a "biotech" lab. We will correct that quickly: biotechnology is merely a process, a way of getting things done. Biostress is a concept, covering all the stresses—plant, animal, and human—that eat away at the quality of life back home on the farm, ranch, or South Dakota community. It is a challenging concept, worthy to name a building after.

There are other "bright spots" on campus. Students and parents already familiar with SDSU have seen more changes this year than just the "construction congestion" around the Biostress Lab.

The new swine unit was dedicated in January and is now in use. The sheep barn is under construction, and the Veterinary Science barn that was destroyed by fire has been replaced. In the planning stage are an addition to the Vet Sciences building and Diagnostic Lab and a new dairy production unit. We've been able to make some minor repairs we've had to put off in past years. We've also spruced up some of our out-state research stations.

Good facilities like these improve the amount and quality of work we can do. They give us options and the opportunity to adapt more quickly to changing needs. They make the work place more efficient and safer. I'm very pleased to report this kind of progress.

So, the general feeling here at SDSU is upbeat. The winter research projects are in full swing; the scientists are pouring over their data collected in the field this summer, and the young people continue to energize us. If you still worry about your student, plan a campus visit, and while you're here, stop in and meet the folks in the Experiment Station. ❑

photo: Kevin Schmidt

Ray Moore explains that biostress is a concept that covers all stresses that erode "quality of life."

Dr. R.A. Moore is director of the South Dakota Agricultural Experiment Station.

photo: Jerry Leslie

Plant stress research puts 'answers' in your fields

Fred Cholick

It's not hard to describe biostress. It's just hard to bring it down to size and then do something about it.

Biostress is whatever keeps an organism from achieving its potential. And that is the first problem for a South Dakota plant scientist: In this state we don't even know what the potential of a plant is, how big it could grow, how much yield it could give, how long it could live. The state, good as it's been to us over the years, continually throws stresses at crops, gardens, trees, even native plants which ought to be able to take what nature dishes out.

The other problem is that biostress is plural and we've only been able to deal with singulars, with one biostress at a time. South Dakota is a series of never-ending biological stresses—soils, climatic conditions, diseases, weeds, insects, and finally, the crops and plants themselves. Bad enough individually, these stresses usually interact with each other and make things worse.

There is little we can do to change climatic stresses. We live where conditions are extreme: When it rains, it pours; when it isn't pouring, it forgets how to rain; when it's warm, it's hotter than blue blazes; and when it cools down, it freezes.

All we can do is temper those extremes, adapt our crops and our agricultural techniques to them to reduce their negative impact. There's plenty already done—new varieties, modified tillage practices, and changes in cropping patterns. There will be more, once results start rolling out of the Biostress Lab at SDSU.

Rough as things may be above ground, underneath the soil surface is the primary contact point between plant and environment and where stress often has a habit of first showing up. The root system is essentially the conduit obtaining and transporting essential nutrients and water for plant growth and development. The soil around those roots determines just how easily that will be done.

We have found differences in growth patterns of corn root systems, for exam-

ple, differences which can potentially be translated into corn lines that have a greater efficiency to collect water and nutrients.

Rooting patterns also relate to soil fertility management. Corn lines respond differently to localized levels or concentrations of nutrients. We know this happens, but don't ask us "how" or "why" until we've moved into the Biostress Lab and have a chance to examine these mechanisms.

Three additional stresses are diseases, weeds, and insects. Each has its own identity and produces its own impacts. Each also can capitalize on any opening left by another stress: root rot thrives in water-logged soils; grasshoppers materialize in dry, hot months; secondary infections spread in a wound.

Before we understand this "big picture," we start at the individual-stress level, understanding the differences within a given disease. Identification techniques at the molecular level are emerging. We are presently investigating the genetic diversity of Phytophthora root rot in soybeans and wheat streak mosaic virus, for example. Then we can start adding other stress effects, such as how climatic conditions affect weed/crop and pesticide/soil relationships.

Climatic factors directly impact the amount of loss from competition, performance and control programs, and carryover of herbicides. Recent studies indicate that early competition and carryover are of critical importance in South Dakota. The interactions of weed competition, plant ecology, plant physiology, soil factors, and crop management strategies will be investigated under field and lab conditions.

The final component in the biostress picture is the plant itself. Sometimes the plant "outwits" itself and creates internal stress, and it takes an increased knowledge of biochemistry and plant physiology to understand how certain chemical compounds—or their absence—can inhibit growth and crop yield. Then the questions expand to include how the plant reacts to outside stresses.

These questions are not unanswerable. Troy oats is an example of questions solved. Recently released, this variety has a high degree of resistance to leaf rust. It is the most resistant to crown rust of any variety currently under test in South Dakota. It also has good tolerance to a viral disease that causes red leaf. These characteristics add to the stability of Troy's productivity, but the variety also must have good agronomic characteristics, such as test weight, straw strength, and yield potential. One effect of stress we couldn't lick with Troy is test weight. Under hot or dry conditions, test weight will drop faster than average. Therefore, Troy is best adapted to the northeast section of the state. There is no "super oat" that will overcome all biostresses in South Dakota.

photo: Ag Communications file

We can never totally eliminate the stresses of flood, facing page, and hail, says Fred Cholick, head of the Plant Science Department, but SDSU researchers have determined how to temper their effects. Cultural practices and intensified crop rotations have a large impact on reducing soil erosion.

South Dakota is one of the greatest places in the world in which to do biostress research. Yet at times, some biostresses get in our way of investigating others. For example, July 1992—coldest on record in Brookings—did little for our research projects evaluating heat-tolerance mechanisms of plants.

That's where the Biostress Lab comes in. Its labs, growth chambers where we can isolate and then combine stresses, and high-tech machinery will help us manage stress in the field.

The ultimate answers may be discovered in the Biostress Lab. Their full potential won't be realized, however, until they're tested out in our research plots and then passed on to you. ❑

Dr. Fred Cholick is head of the Plant Science Department, SDSU.

Horticultural research seeks to widen your choices

Carter Johnson

For years, the SDSU Department of Horticulture, Forestry, Landscape, and Parks has helped South Dakotans adapt to the state's climatic rigors by introducing stress-adapted plants from other regions and breeding and selecting local stress-tolerant plants.

For example, nearly a hundred years ago, Dr. N.E. Hansen, famed plant explorer and former head of the department, searched for useful plant material in parts of Asia with a climate even more extreme and variable than that of South Dakota. Many of the plants he introduced, such as alfalfa, crested wheatgrass, and Harbin pear, have become economically important, well-adapted plants in our region.

From such introduced plants and from hardy natives, researchers at SDSU have produced other stress-resistant varieties. Bred and selected in South Dakota for South Dakota conditions have been windbreak trees (Siouxland cottonwood), fruit trees and grapes (Gourmet pear, Luscious pear, Valiant grape), garden vegetables (Super Chief and Rushmore tomatoes, Pick-Me-Quick pepper), and ornamental trees and shrubs (Homestead buckeye, Nugget ninebark, Meadowlark forsythia).

By such time-proven breeding and selection, we will continue to supply promising tolerant plants from the N.E. Hansen Research Center, McCrory Gardens, and the South Dakota Arboretum. But now the Biostress Laboratory will also enable us to also use "biotech" to combat "biostress." We will be able to use new tactics, particularly in stress physiology and genetics, to understand the ways stress affects plants. This will reduce the time we have previously spent in evaluation before plants are released to the public.

For example, Dr. Peter Schaefer will be able to accelerate breeding programs for Rocky Mountain juniper and eastern redcedar, which represent a majority of all trees in windbreak, farmstead, and conservation plantings in the Great Plains.

photo: Carol Wake

This 6-year-old black locust has never suffered any winter injury, says Dr. Pete Schaefer. The species is not native to South Dakota. In the Brookings area, most trees freeze back in the winter, making this young giant, from the N.E. Hansen Research Center east of the SDSU campus, a possible parent in a hardiness breeding program.

We once thought these two junipers hybridized in nature. Recent work indicates that they are actually two different species. This explains why it may be difficult to combine the coloration and attractiveness of the one with the growth habits and sturdiness of the other. Genetic improvement of trees is already very difficult and slow, due to their delayed age before seed production. Therefore, the more we know about hybridization potential before we make crosses and field tests, the sooner improved junipers can be growing on your property.

In the Biostress Lab, we expect to be able to physically enter and explore juniper chloroplasts, the bodies in the plant cell that are the "food factories" of the plant, and examine their DNA. Chloroplasts are good places to study how different junipers are related.

A second stress research project also will benefit from new facilities in the Biostress Lab. Dr. Anne Fennell will direct the Cold Hardiness Lab with a focus on the acclimation, or hardening, and winter survival of woody fruit crops.

Many fruit varieties that can be grown in other northern states do not survive the winters in South Dakota. Our high and low temperature extremes, winter temperature fluctuations, wind, and drought all are stresses that have limited our choices of fruit trees in this state.

Much of past stress research on woody plants has concentrated on surviving low temperatures. But the Halloween freeze of 1991, which extensively damaged trees, clearly showed us that the timing of hardening is as important as the ability to live through very low mid-winter temperatures.

Within the genes of a plant are those that regulate the change from active growth to dormancy. With the high-tech facilities in the Biostress Lab, we will be able to find and characterize them, and "store" them in gene libraries. Then we can withdraw the appropriate genes from the library and insert them into plants that will withstand the environmental extremes of South Dakota.

We look forward to the day when South Dakotans can grow the wide variety of crops and ornamentals that people in more gentle climates already enjoy. ❑

Dr. Carter Johnson is head of the Department of Horticulture, Forestry, Landscape, and Parks at SDSU.

photo: Jerry Leslie

Animal stress research tied to 'making a living'

John Thomson, John Parsons, and Jim Males
(compiled by Jerry Leslie)

Maintaining and improving the $8.7 billion livestock industry in South Dakota is a challenge to individual livestock producers and their support professionals at SDSU.

Making a living from animal agriculture means raising livestock that can survive and prosper in the hot and cold weather of the Northern Great Plains and the sometimes semi-arid climate of the western part of the state. It means overcoming ongoing nutritional and disease pressures in the feedlot, farrowing house, or dairy barn.

Biostress research into animal agriculture always has been and always will be serious business at SDSU, because a viable ag economy is essential to the welfare of the entire state.

Animal biostress research occurs primarily in three related departments at SDSU—Animal and Range Sciences Department, Dairy Science Department, and the Veterinary Science Department.

The Animal and Range Sciences Department has a long history of biostress-related research.

At the Cottonwood Range and Livestock Station near Philip, researchers compare the effect of grazing intensity on native vs. introduced grass species.

The ranges at Cottonwood are classified as poor, good, and excellent. South Dakota's environmental conditions, such as drought, extreme cold, and heat, are important factors in evaluating this research.

The beef cattle breeding project is designed to evaluate the cow type that is the most suitable for South Dakota's range conditions. The cow herd is located at the Antelope Range Livestock Station at Buffalo.

Again, the effect of environment on the range forage and cattle determine the cow size and milk production that is the most practical.

The Antelope Station is also home to a ewe flock that serves as the range flock in a comparison of sheep in a farm flock vs. range setting. The ewe flocks are the same in breeding. Lambs per ewe, pounds of lamb weaned per ewe, and wool production are evaluated.

Recently, a major study of retained ownership of beef cattle has been under way in cooperation with a private feed yard Kimball. As a part of this project, cattle from one South Dakota ranch were split into three groups.

One group was shipped directly to Brookings and fed at the Beef Cattle and Sheep Nutrition Unit. The second group

was hauled half way to Lubbock, Texas, and was returned to Brookings where they were fed. The third group was in fact shipped to Lubbock and fed at Texas Tech University.

The overall gains were the same among the three groups, with the cost of gain less for the cattle fed in Brookings.

The bottom line is that there is no advantage for the producer to ship cattle out of South Dakota in hopes of profiting from better feedlot performance in a less harsh climate like that found in Texas.

The Dairy Science Department is evaluating two areas of biostress: 1) helping the cow meet the nutritional stress brought on by high milk production, and 2) helping control environmental stresses on cows.

An illustration of "nutritional stress" is that many cows today produce more than 100 pounds of milk daily for several months each year. And even more cows will be in this group in the future.

One hundred pounds of milk contain 12 pounds of nutritional milk solids. It is a challenge to dairy scientists to develop nutritionally balanced diets and to help these cows eat enough of those diets to maintain high production, good health, and reproductive capabilities.

One area of research which will receive additional attention will be boosting the energy content of the cow's diet with supplemental fat sources such as soybeans, sunflower seeds, and tallow.

Also to be studied will be improved protein nutrition, particularly high quality feed proteins and amino acids that will escape degradation in the cow's rumen but will be digested and utilized in her intestinal tract. These are often referred to as "bypass proteins."

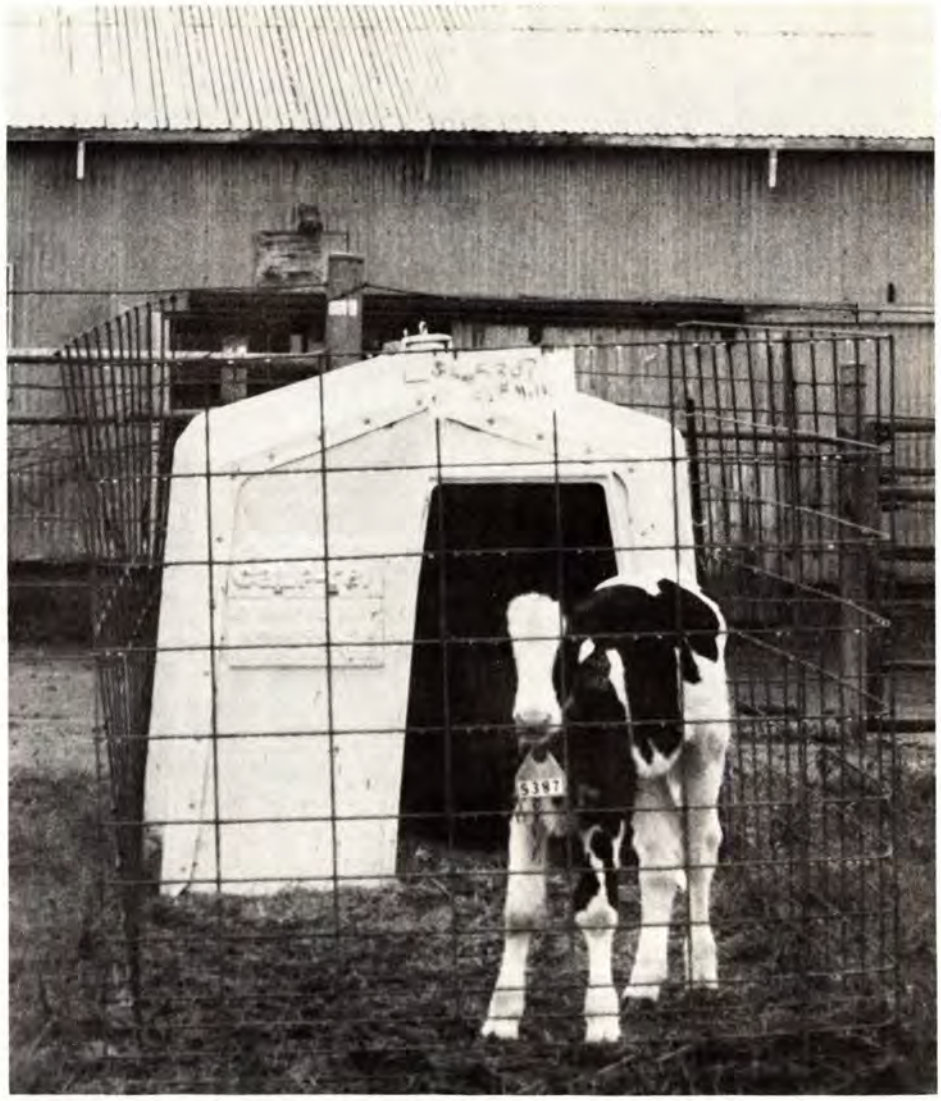

photo: Jerry L

Grasslands, previous page, occupy about two thirds of the state and are the base for much of South Dakota's $8.7 billion livestock industry. Above, a significant part of the livestock industry is dairying. SDSU researchers found that "hardening off" young dairy calves outdoors in individual hutches cut losses to pneumonia from 40 percent of the calf crop to virtually zero percent. An extra 2 pounds of milk daily is all a calf needs to sail through the coldest winter months.

Both hot and cold environmental stresses affect cattle in the Upper Midwest. Sprinklers were installed in the SDSU dairy barn a few years ago to help cool cows during hot weather. An immediate 2-pound-per-day increase in feed intake was observed with a corresponding increase of several pounds of milk.

The planned new dairy barn will include curtained sidewalls. These will allow greater air movement and a cooler environment during warm weather. The curtains can be closed as much as necessary during colder times of the year to maintain a comfortable environment. One of our present barns is also being remodeled to include curtained sidewalls.

SDSU is a leader in housing calves in outdoor hutches. Our research has demonstrated that these calves may need a little higher-energy diet during cold weather to supply the extra energy needed for the calf to keep warm. Simply feeding the calf 10 pounds of milk daily in two feedings, instead of 8 pounds daily, will usually give a calf the needed extra boost on a cold day in January.

Disease is commonly described as suboptimal production resulting from an imbalance between the host animal, environment, and disease pathogens.

A number of factors, acting together to impact the health and well-being of animal populations are certain "biostresses." These include the age, concentration, and genetic susceptibility of the host animals, the shelter, water, nutrition, and herdsmanship provided, and the pathogens present, whether viruses, bacteria, fungi, or toxins.

The Veterinary Science Department and Animal Disease Research and Diagnostic Laboratory provide laboratory diagnostic assistance and results-oriented research to animal disease problems threatening the $8.7 billion livestock industry in South Dakota.

photo: Jerry Leslie

Beef cattle breeding projects focus on cow type. Certain types are more suited for South Dakota range conditions where researchers must strike a balance between desirable breed characteristics and forage capabilities.

photo: Emery Tschetter

Until a world-class discovery in the SDSU Veterinary Science Department, Mystery Swine Disease typically cost a producer $250 to $500 per sow in lost pigs. Now that producers can identify animals carrying the disease, the estimated savings to the economy in South Dakota alone is a conservative $4 million, veterinarians estimate.

The lab processes more than 26,000 cases per year. The diagnostic investigations of livestock disease problems allow the Veterinary Science Department's faculty and staff daily exposure to the current problems facing South Dakota producers.

In the late 1980s, the United States swine industry recognized an emerging reproductive and respiratory disease called Mystery Swine Disease. In 1991, SDSU Veterinary Science researchers discovered the causative agent of MSD by integrating diagnostic efforts with results-oriented research.

These SDSU Veterinary Science research efforts are contributing valuable information for local, regional, national, and global trade and marketing decisions.

The department and laboratory research is focused and has achieved national prominence in intestinal, respiratory, and reproductive diseases of livestock. The area of genetic resistance to disease will play a significant role in food safety and preventive medicine practices of the future.

SDSU Veterinary Science researchers recently identified the protein receptors associated with the susceptibility of pigs to *E. coli* bacteria. As diagnostic testing techniques are developed, swine producers should be able to genetically select for resistance to this disease.

SDSU Veterinary Science diagnosticians have contributed significant scientific information on newly recognized parasites associated with bovine abortions. Development of control measures for this condition will have a significant economic return to the South Dakota cattle industry.

Current Veterinary Science biostress-related research investigations include:

The role of boar semen in the transmission of Swine Infertility and Respiratory Syndrome (also known as Mystery Swine Disease).

The prevention and control of intestinal diseases of swine.

Risk factors associated with the bovine respiratory disease complex, including pathogens, diagnosis, and management.

Bovine virus diarrhea infections in herd health.

Identification and characterization of cellular receptors to disease-causing pathogens.

Epidemiology and control of Johne's disease in South Dakota livestock.

Characterization of the virulence capacity of *E. coli* causing bloody scours.

Characterization of the interaction between bacterial toxins and leukocytes.

These three departments will continue to work together in behalf of the economic viability of the South Dakota livestock industry—searching for breakthroughs, small and large, in biostress research that will help South Dakota producers feed and clothe the nation and the world. ❑

Dr. John Thomson is acting head of SDSU's Veterinary Science Department and Animal Disease Research and Diagnostic Laboratory; Dr. John Parsons is head of the SDSU Dairy Science Department; Dr. Jim Males is head of the SDSU Animal and Range Sciences Department; and Jerry Leslie is news writer in the Department of Agricultural Communications, SDSU.

photo: K[illegible]chmidt

Human stress research seeks to improve 'quality of life'

Larry Tennyson and Robyn Heine

The effect of the climate and other environmental factors on human beings is yet another priority in biostress research at SDSU.

Such research occurs mainly in the Departments of Economics and Rural Sociology and the College of Home Economics. Some of it involves collaboration between the departments and the College; other research is conducted by each agency individually, explains Dr. Virginia Clark, Dean of the College of Home Economics.

One type of such research is being conducted by the Census Data Center located in the Department of Rural Sociology. The Center analyzes information relevant to current issues facing South Dakotans. It obtains the information from the U.S. Bureau of the Census and the state of South Dakota.

Such information includes data on poverty trends, housing data, household and family information, quality of rural and small-town life, rural development, farm crisis effects, and out-migration of population from rural areas.

Center Director and Department Head is Dr. James Satterlee. Assistant Director is Dr. Don Arwood.

Dr. Arwood describes one study that measures the quality of life in various parts of the state and the impact of displaced farmers on rural communities.

But that's only a part of the Center's efforts.

The Center, which was established in 1981, also provides information that

photo: Tom Dobbs

Facing page, consumers, share in the benefits from crop and livestock research, because economic assessment of different production options are built into most projects. Above, Dennis Schaefer, Tripp; a visiting professor from China; and Don Taylor, SDSU Economics Department, pause during a tour of Schaefer's sustainable ag enterprise.

photo: Duane Hanson

The biggest business in a small town is usually the elevator. Some elevator operators are concerned that a big switch to sustainable agriculture by farmers in their trade area will close down their fertilizer sidelines. Some main street business owners also fear a drop off in trade. Normally, sustainable farmers spend less on purchased inputs and also may have lower incomes, particularly in the switch-over years from conventional to sustainable farming. Other rural community leaders are more optimistic, believing that sustainable farming adds stability to the economy since such a practice tends to be diversified. SDSU studies indicate that, given present conditions, there will be no overnight switch to sustainable agriculture and that the speed with which it is adopted depends on location in the state.

helps community leaders make informed decisions concerning the distribution of funding from revenue sharing, block grants, and poverty programs. The information helps in decisions relating to school district reorganization and economic development.

Meanwhile, the Center continues to provide both research support and demographic information for other biostress research projects at SDSU.

According to Dr. Ardelle Lundeen, head of the Department of Economics, investigating the implications of sustainable agriculture systems for rural communities is an example of a more narrowly focused type of research.

Sustainable agriculture is a management system designed to prevent degradation of natural resources while still producing adequate food and incomes to meet basic human needs.

But when farmers limit their use of chemical fertilizers—a practice associated with the sustainable agriculture system—how does this impact their yields and their eventual income? Furthermore, when fewer inputs such as fertilizers are purchased for raising crops, how does this affect local agribusiness and the economy of the rural community?

Some believe it may harm the overall rural economy, while others say it actually might provide a foundation for the economic health of South Dakota's rural communities.

Department researchers found that the economic effect of the sustainable agriculture system varies from one part of the state to another in the short run. This is because of the differences in the type of crops that the local climate will best support.

For instance, minimizing the use of chemical fertilizers in a corn-soybean area of the state, such as the southeast, will have a greater economic effect than doing the same thing in a wheat-producing area such as the west or the northeast.

So, sustainable agriculture will have more of a negative effect on local economics in the southeast than it will in the northeast or west.

Researchers also determined that dramatic changes in some combination of commodity prices, federal farm policy, or environmental regulation would be required to make sustainable agriculture more profitable in the corn-soybean areas of the state.

Lundeen said another research study associated with human stress is one that profiled 101 farm debtors who had filed for Chapter 12 bankruptcy during the period from November 1986 through January 1988.

Such bankruptcy had increased dramatically during the 1980s because of severe financial stress then being suffered by farmers due in part to adverse weather conditions.

The overall purpose of the study was to measure whatever positive effect Chapter 12 bankruptcy provisions had in helping farmers minimize that stress.

At this point, all baseline data has been collected and analyzed.

The second phase of the study is to see how many debt reorganization plans were successful and to measure the influence Chapter 12 had on the decisions of agricultural lenders, including the credit terms they extended to these same farm families.

Several other research projects in the Economics Department have examined farmers' financial viability under changing yields and prices. These research findings also clearly indicate that any biostress research that helps to stabilize yields is a keystone in the overall improvement of South Dakota's rural economy.

In addition to ongoing projects such as these, research in Lundeen's department also plays a role in helping to assess the associated economics of other SDSU plant and animal studies.

photo: Kevin Sc...

When a little boy has to keep the water fresh and the feed box full but can still take time to squeeze one of his charges, he probably learned to combine work and play from his folks. A multi-department research project at SDSU has found that farm families which have integrated their farm business and their family activities are more successful and more able to handle stresses and crises than are families who tend to emphasize either the business or the family side of the operation.

But a more direct collaboration is a research project involving the Economics Department and both the College of Home Economics and Department of Rural Sociology.

Researchers included Dr. Clark, Dr. Larry Janssen of the Department of Economics, Dr. Ron Stover of the Rural Sociology Department, Mr. Scott Peterson, Research Associate in the Department of Economics, and Mrs. Peggy Schlechter, Graduate Assistant in the College of Home Economics.

The purpose of their study was to discover the tactics and procedures which farm families develop or learn when they adapt to change and crises.

One part of the project included detailed personal interviews with 16 selected farm couples identified as "successful" by the Cooperative Extension Service.

The couples were selected on the basis of their having maintained or increased their earned net worth and having had successful family lives. They also were between the ages of 26 and 59. Furthermore, the families were selected so that the locations of their farms would provide a cross-sectional sample of farming operations typical of present-day South Dakota agriculture.

By identifying the characteristics that were held in common among the successful farm families—and which have enabled them to succeed both in their farming operations and in their family life—researchers have provided other farm couples something akin to a survival manual for coping with difficult economic times.

"Overall, family farming requires an integrated approach to business management and family life. For most farm couples, successful farm business management and successful family life are very much interrelated," said Janssen. ❑

Dr. Larry Tennyson is communications specialist in the Department of Agricultural Communications; Robyn Heine is a journalism intern in the Department of Agricultural Communications.

105th Annual Report

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Kent Klinker, Onida
Barry Muxen, Doland
Roger Rix, Groton
Roger Scheibe, Pierre
Mark Stiegelmeier, Selby
Steve Taylor, Presho
Pat Tracey, Pierre
Tom Tviet, Pierre

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Lee Qualm, Platte
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George Turner, Glenham
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Northeast Research Farm

Bill Bisgard, Waubay
Lynn Eberhart, Britton
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Donald Guthmiller,* Hayti
Larry Jost,* Webster
Orrin Korth, Watertown,
Loron Krause, Clear Lake
Lyle Kriesel, Summit
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James Smolik (Manager),** Brookings
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Bob Davis (Dist Ext Supervisor), Brookings

*County Extension agent
**Non-voting advisor

SESD Research Farm

Kevin Crisp, Dell Rapdis
Terry Dolan, Beresford
Darrell A. Edelman, Menno
John Fahlberg, Beresford
Ron Hesla, Wakonda
Willie Huebner, Akron, Ia.
Leon Jorgenson, Freeman
Dean Knutson, Centerville
Lea Lanfear, Lake Andes
John Olbertson, Beresford
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Merlin Peterson, Irene
Merlyn Smeenk, Harrisburg
Dean Weber, Wagner

Staff

Agricultural Communications

E.J. Tschetter, MS, department head
M.R. Brashier, MS, assistant professor, communication specialist-publications
J.R. Leslie, BS, instructor, communications specialist-ag news and features
L.K. Tennyson, Ed.D, associate professor, communications specialist-publications and special projects

Agricultural Engineering

R. Alcock, PhD, associate professor and head
G.A. Anderson, PhD, associate professor
S.T. Chu, PhD, professor
D.W. DeBoer, PhD, professor
D.S. Humburg, PhD, assistant professor
J.L. Julson, MS, assistant professor
V.C. Kelley, MS, assistant professor
T.M. Klosterman, BS, farm superintendent
M.A. Schipull, MS, assistant professor
K.W. Stange, MS assistant professor
H.D. Werner, PhD, professor

Animal and Range Sciences

J.R. Males, PhD, professor and head
C.P. Birkelo, PhD, assistant professor
W.J. Costello, PhD, professor
R.J. Emerick, PhD, professor (joint appointment with Station Biochemistry)
F.R. Gartner, PhD, professor and director, West River Agricultural Research and Extension Center, Rapid City
S. Goodfellow, manager, beef breeding unit
D.H. Gee, PhD, professor
R.H. Haigh, BSm superintendent, Range & Livestock Research Station, Philip
C.R. Hamilton, PhD, associate professor
W.T. Heylens, manager, swine unit (resigned 6/3/92)
C.L. Johnson, BS, research assistant
J.R. Johnson, PhD, professor
P.S. Johnson, PhD, assistant professor
G.W. Libal, PhD, professor
D.M. Marshall, PhD, assistant professor
D.C. McFarland, PhD, assistant professor

H.L. Miller, PhD, associate professor
K. Nagel, manager, feed processing unit
D. Peters, MS, research associate/swine research unit supervisor (began 10/3/92)
R.H. Pritchard, PhD, associate professor
R.J. Pruitt, PhD, associate professor
B. Read, BS, manager, sheep unit
M.M. Robbins, BS, manager, nutrition unit (resigned 4/4/92)
J.R. Romans, PhD, professor
A.L. Slyter, PhD, professor
B.F. Sowell, PhD, assistant professor
R.H. Swan, BS, superintendent, Antelope Range Livestock Station, Buffalo
R.N. Swanson, PhD, professor (joint appointment with Veterinary Science)
K.E. VanderWal, BS, manager, cow-calf teaching & research unit
J.L. Wagner, PhD, associate professor
L. Warborg, manager, meat laboratory
M. Zehms, MS, manager, beef cattle & sheep nutrition research unit (began 8/1/92)

Biology/Microbiology

C.R. McMullen, PhD, professor and head
C.H. Chen, PhD, professor
W.R. Gibbons, PhD, assistant professor
N.H. Granholm, PhD, professor
D. Hurley, PhD, assistant professor
R.N. Reese, PhD, assistant professor
C.A. Westby, PhD, professor

Dairy Science

J.G. Parsons, PhD, professor and head
R.J. Baer, PhD, associate professor
K.A. Baldwin, MS, instructor/dairy plant manager
W.W. Foster, PhD, assistant professor
G.A. Harrison, PhD, assistant professor (resigned 5/31/92)
D.R. Henning, PhD, associate professor
K.M. Kasperson, BS, research assistant
F.C. Ludens, BS, instructor/manager, dairy farm
V.V. Mistry, PhD, associate professor
D.J. Schingoethe, PhD, professor
B.G. Schroder, MS, research associate

Economics

A.A. Lundeen, PhD, professor and head
M.K. Beutler, PhD, assistant professor
T.L. Dobbs, PhD, professor
W.D. Ellingson, BS, instructor
D.M. Feuz, PhD, assistant professor
D.R. Franklin, PhD, assistant professor
L.L. Janssen, PhD, professor
C.E. Lamberton, PhD, professor
B.A. Qasmi, PhD, assistant professor
D.C. Taylor, PhD, professor

Home Economics

V.L. Clark, PhD, professor and dean
M.G. Crews, PhD, professor and head
F.A. Bohannon, PhD, assistant professor
P.G. Krishnan, PhD, assistant professor
L.A. Scholten, MS, instructor

Horticulture, Forestry, Landscape & Parks

W.C. Johnson, PhD, professor and head
S.E. Boettcher, MS, research assistant
M.D. Dixon, BS, research assistant
M.E. Enevoldsen, MS, research associate
A. Fennell, PhD, assistant professor
N.P. Evers, BS, instructor
P.D. Prashar, PhD, professor
P.R. Schaefer, PhD, associate professor
P.L. Spinski, PhD, assistant professor (resigned 8/28/92)
R.L. Stubbles, PhD, assistant professor

Plant Science

F.A. Cholick, professor and head
D.L. Beck, PhD, associate professor, manager, Dakota Lakes Research Farm
G.R. Benoit, PhD, adjunct professor (USDA/ARS) (retired 8/31/92)
A.A. Boe, PhD, professor
M.A. Boetel, MS, research associate
J.J. Bonnemann, MS, assistant professor (retired 4/17/92)
R.R. Bortnem, MS, research associate
T.F. Branson, PhD, adjunct associate professor (USDA/ARS) (retired 2/1/92)
K.A. Brix-Davis, MS, research associate
B.C. Byers, BS, research assistant
G.W. Buchenau, PhD, professor
R.A. Burnan, PhD, adjunct assistant professor (USDA/ARS) (retired 4/30/92)
E.T. Butler III, PHD, adjunct associate professor
C.G. Carlson, PhD, associate professor
C.D. Carter, PhD, associate professor
T.E. Chase, PhD, assistant professor
S.A. Clay, PhD, assistant professor
D.E. Clay, PhD, assistant professor
D.A. Claypool, MS, research associate (resigned 9/20/91)
J.J. Doolittle, PhD, assistant professor
S.M. Drymalski, BS, research assistant
C.D. Dybing, PhD, adjunct professor (USDA/ARS)
M.M. Ellsbury, PhD, adjunct professor (USDA/ARS)
A.M. Espinasse, DAG, assistant professor (resigned 9/25/92)
P.D. Evenson, MS, professor
B.G. Farber, MS, research associate, manager, Central Research Station
P.E. Fixen, PhD, adjunct associate professor
B.W. Fuller, PhD, assistant professor
D.J. Gallenberg, PhD, associate professor
H.A. Geise, MS, assistant professor
R.H. Gelderman, PhD, assistant professor, manager, Soil and Plant Analytical Lab
J.L. Gellner, PhD, assistant professor (resigned 9/8/92)
K.A. Grady, MS, assistant professor
R.D. Gustin, PhD, adjunct assistant professor (USDA/ARS) (retired 1/3/91)
L.A. Hall, MS, research associate
G.R. Hoffman, PhD, adjunct professor, Biology, USD, Vermillion (resigned 7/1/92)
J.A. Ingemansen, MS, manager, Foundation Seed Stocks
A.L. Kahler, PhD, adjunct professor
D.G. Kenefick, PhD, professor
R.W. Keickhefer, PhD, adjunct professor (USDA/ARS)
K.D. Kephart, PhD, assistant professor
J.A. Koepke, BS, research assistant
R.A. Kohl, PhD, professor
D.R. Lance, PhD, adjunct assistant professor (USDA/ARS) (resigned 2/1/92)
M.A. Langham, PhD, assistant professor
M.J. Lindstrom, PhD, adjunct associate professor (USDA/ARS)
D.D. Malo, PhD, professor
B. McDaniel, PhD, professor (retired 10/27/92)
M.M. McGiffen, PhD, adjunct assistant professor (USDA/ARS) (resigned 9/1/92)
W.C. Moldenhauer, PhD, adjunct professor (USAD/ARS)
A.E. Olness, PhD, adjunct associate professor (USDA/ARS)
R.J. Pollmann, MEd, associate professor, manager, Seed Certification Service
J.E. Powell, PhD, adjunct professor (USDA/ARS)
D.L. Reeves, PhD, professor
D.H. Rickerl, PhD, associate professor
W.E. Riedell, PhD, adjunct assistant professor (USDA/ARS)
J.C. Rudd, PhD, assistant professor
K.A. Scholes, MS, research associate
T.E. Schumacher, PhD, associate professor
J.A. Schumacher, PhD, research associate
R.A. Scott, PhD, assistant professor
J.D. Smolik, PhD, professor
D.R. Sorensen, MS, instructor, manager, SESD Research Farm (resigned 7/10/92)
C.E. Stymiest, MS, associate professor
G.R. Sutter, PhD, adjunct professor (USDA/ARS)
F. Sutton, PhD, assistant professor
E.B. Turnipseed, MS, instructor, manager, Seed Testing Lab
T. Wang, PhD, research associate (resigned 8/31/91)
M.F. Westgate, PhD, adjunct professor (USDA/ARS)
Z.W. Wicks III, PhD, professor
H.J. Woodard, PhD, assistant professor

Station Biochemistry

D.C. Hilderbrand, PhD, professor and head
N.A. Anderson, BA, research assistant
R.J. Emerick, PhD, professor
D.P. Evenson, PhD, professor
J.E. Houglum, PhD, professor
W.P. Jensen, PhD, professor
L.K. Jost, MS, research assistant
H. Kayongo-Male, PhD, associate professor (joint appointment with Bio/Micro)
D.G. Kenefick, PhD, professor (joint appointment with Plant Science)
D.P. Matthees, PhD, professor
D.C. McFarland, PhD, adjunct assistant professor
I.S. Palmer, PHD, professor
F. Sutton, PhD, research associate
N.J. Thiex, MS, assistant professor
T.P. West, PhD, associate professor

Veterinary Science

J.U. Thomson, DVM, MS, associate professor and acting head
D.A. Benfield, PhD, professor
C. Chase, DVM, PhD, assistant professor
J. Christopher-Hennings, DVM, MS, research associate
D.H. Francis, PhD, professor
D.J. Hurley, PhD, assistant professor
D.D. Johnson, DVM, PhD, professor
D. Miskimins, DVM, MS, assistant professor
D.T. Nelson, DVM, MS, professor
E.A. Nelson, MS, instructor
J.C. Nietfeld, DVM, PhD, assistant professor
I.J. Stotz, MS, instructor
M.J. Yeager, DVM, PhD, assistant professor
D.H. Zeman, DVM, PhD, associate professor

Wildlife and Fisheries Sciences

C.R. Scalet, PhD, professor and head
C.R. Berry, PhD, adjunct professor
W.G. Duffy, PhD, adjunct assistant professor
L.D. Flake, PhD, professor
K.F. Higgins, PhD, adjunct associate professor
D.E. Hubbard, PhD, assistant professor
J.A. Jenks, PhD, assistant professor
D.W. Willis, PhD, associate professor

Projects

Agricultural Engineering

H-160 Interior conditions and technical considerations for livestock housing; Froehlich, Anderson, Pohl
H-179 Crop harvesters (combines) and soil compaction; Froehlich, Alcock, Durland
H-189 Applying and recording ag chemicals simultaneously via computer control; Froehlich, Klosterman, Alcock, Durland, Stange
H-190 High-temperature short-time extrusion processing of renewable agricultural materials; Julson, Krishnan
H-200 Water management of glacial till soils to sustain profitable crop production and minimize adverse environmental impacts; DeBoer, Stange, Chu, Werner
H-210 Design and performance of agricultural structures; Anderson, Schipull
R-239 Variables in agricultural weather information systems; DeBoer, Stange, Chu, Werner
H-249 Root growth and mechanical impedance of soils; Alcock, Schumacher, Froehlich
H-261 End effector design for automated handling of biological materials; Humburg
H-271 Machine vision applied as a sensor for automation in agriculture; Humburg
H-310 Modeling contaminant movement in unsaturated soil with a new water flow network; Chu, Kohl, Carlson

Animal and Range Sciences

H-049 Nutritional management to minimize costs and improve reproductive performance of beef cows; Pruitt
H-059 Age-weight dependent mechanisms of skeletal muscle growth in cattle; Pritchard
R-079 Genetics of body composition in beef cattle; Marshall
H-090 Overstory, understory, and soil water relationships of hydrologic units in the Black Hills; Gartner, Sowell
H-101 Physiological and nutritional interactions that affect growing pigs; Hamilton, Libal
H-120 Patterns of defoliation and plant response to grazing; P. Johnson
H-128 Reducing breeding seasonality in the ewe; Slyter
H-141 Low-fat meat snack food: procedures, shelf life and raw materials; Costello, Romans, Crews
H-151 Beef cow production efficiency and the interaction of plane of nutrition and genotype; Birkelo, Marshall, Miller
H-220 Effects of prepubertal rbST exposure and energy intake on development of beef cows; Pritchard
H-251 Improving the composition and location of animal fat to make meat more healthful; Romans
H-268 Influence of grazing system changes on range productivity and related values; J. Johnson
H-289 Influence of gonadotrophin releasing hormone implants on reproductive performance in beef cattle; Miller, Goehring

H-290 Effects of balance and level of indispensable amino acid on daily feed intake by swine; Hamilton, Libal
H-301 Nutrition and management influencing reproductive efficiency of swine; Libal, Hamilton
R-307 Increasing prolificacy in sheep and its impact on nutritional needs; Slyter
H-319 Managing corn grain, corn silage, and alfalfa hay in cattle feeding and farming operations; Wagner
H-321 Effect of antibody and toxin on mulberry heart disease complex in the weaned pig; Libal, Hamilton
H-340 Cattle and sheep grazing alone and in combination on the Northern Great Plains; Sowell
R-390 Factors regulating protein synthesis, degradation, and growth in skeletal muscle; McFarland

Biology/Microbiology

H-089 Enhanced reproductive efficiency - molecular genetics of a gene controlling fertility and adiposity; Granholm
H-170 Development and optimization of a calcium magnesium acetate (CMA) production process; Gibbons
H-218 Nitrate reduction in *Azospirillum brasilense*: gene cloning and sequencing and isolation of mutants; Westby
H-221 Rapid fixation and selection for agronomic characters through auther culture of spring wheat hybrids; Chen, Cholick, Bucheneau
H-231 Molecular biology of a mammalian gene which regulates carcass size, fertility, and obesity; Westby
H-311 Echinacea: a potentially new oils crop for the Great Plains; Reese

Dairy Science

H-020 Application of milk concentration techniques in dairy processing; Mistry
H-080 Composition, quality, and consumer acceptance of milk and dairy products; Baer
H-100 Analysis of dairy products; Parsons, Kelley
H-119 Whey utilization of dairy cattle; Schingoethe
H-130 Improving quality and microbial safety of dairy products; Henning
R-137 Metabolic relationships in supply of nutrients for lactating cows; Schingoethe
R-147 Dairy herd management strategies for improved decision making and profitabilty; Foster
H-258 Optimizing the nutritional utilization of forages for dairy cattle; Harrison

Economics

H-011 Sustainability of "organic" versus "conventional" beef production in South Dakota; Taylor, Feuz
H-050 Economics of alternative marketing/management strategies for South Dakota beef cattle producers; Feuz
H-081 Analysis of seasonal patterns in grain prices and evaluation of alternative grain marketing strategies; Qasmi
H-109 Simulation and risk analysis for South Dakota producers and agribusinesses; Ellingson
H-181 Economic and environmental implications of Conservation Reserve Program contract expiration in South Dakota; Janssen
H-191 Policy and economic aspects of sustainable cropping systems; Dobbs
H-219 Economic development impacts of water resource policy on selected projects in South Dakota; Franklin, Lundeen
H-241 Farm financial management of successful family farms in South Dakota; Janssen
R-291 Regulator, efficiency, and management issues affecting rural financial markets; Lamberton
R-348 Impacts of transportation changes on agricultural marketing and local communities; Lamberton
H-370 Economics of rangeland improvement; Beutler

Home Economics

R-039 Reducing pesticide exposure of applicators through improved clothing design and care; Scholten
H-140 Near-infrared reflectance spectroscopy in the measurement of total dietary fiber and beta-glucan; Krishnan, Kephart, Reeves
H-211 Adipose tissue composition and chronic disease patterns; Crews, Simmons
H-338 Characteristics of human physiological reponsiveness to changes in dietary cholesterol levels; Bohannon, Crew, DeZeeuw

Horticulture, Forestry, Landscape and Parks

MS-022 Strategies of resolving forest production versus forest recreation conflicts in the Black Hills of South Dakota and Wyoming; Stubbles
H-052 Environmental stress and fruit production in South Dakota; Fennell
H-069 Vegetable breeding, evaluation, production, and cultural practices to increase yield; Prasher
MS-088 Genetic improvement of tall-tree species for protective forestry applications in South Dakota; Schaefer
H-169 Micropropagation of herbaceous plants; Spinski
MS-299 Evaluation and propagation of superior selections of native and introduced trees and shrubs for South Dakota; Evers
MS-387 Factors associated with the success/failure of ponderosa pine regeneration in the Black Hills, South Dakota; Schaefer
MS-408 Management strategies for conflict use resolution between forest production and forest recreation; Stubbles

Plant Science

H-010 Correlation, calibration, and interpretation of soil and plant tests; Gelderman
H-021 Soybean breeding and genetics; Scott
H-030 Crop rotation system influence on earthworm population in a no-till environment; Beck, Venner
H-031 Etiology and epidemiology of plant viruses in South Dakota; Langham
G-032 SDAES Participation in NAPIAP; Clay, S.
G-041 Tillage induced microrelief impacts on NO3- and atrazine movement in soils; D. Clay, Schumacher, S. Clay
H-058 Spring wheat breeding and genetics; Cholick, Buchenau
H-060 Molecular genetics of lipid and protein biosynthesis in oilseed crops; Carter
G-061 Mapping quantitative trait loci (QTL) using molecular markets in cultivated oats; Reeves, Kahler, Butler
H-070 Soil survey information, soil productivity relationships, and environmental protection in South Dakota; Malo
R-078 Interaction of nematode-host variability and abiotic factors on crop losses; Smolik
H-091 Soybean in vitro; Espinasse-Gellner
H-097 Development and utilization of oats and rye adapted in South Dakota; Reeves
H-111 Agricultural management impacts on wetlands; Rickerl, Bleakley, Hubbard
H-118 Amelioration of claypan or formerly cultivated clay-rich soils to increase range forage production; White
H-138 Corn genetics, physiology, and breeding; Wicks
R-148 Soil productivity and erosion; Schumacher, Lindstrom
H-150 Biological factors contributing to rehydration of winter wheat tissue; Kenefick, Schumacher, Gellner
R-161 Introduction, multiplication, evaluation, preservation, documentation, enhancement, distribution, and utilization of plant germplasm; Wicks
H-180 Modeling and verifying chemical transport within and through the root zone; Carlson
H-199 Frozen soil effects of herbicide movement and weed ecology in conventional and alternative management systems; S. Clay
H-201 Abscisic acid regulated genes in freeze resistance of barley; Kenefick, Sutton, Cheesbrough
H-229 Expert systems for scheduling fungicide applications for wheat disease control; Buechenau, Gallenberg
H-230 Tillage and crop rotations for eastern South Dakota; Sorensen
H-240 Breeding perennial grasses for forage, wildlife habitat, and resistance to insect-related stresses; Boe
H-250 Root systems responses to stress: soil compaction in conservation tillage systems; Schumacher
H-260 Management options for groundwater quality protection within a biostress environment; Kohl, Rickerl, S. Clay
H-269 Alternative farming systems; Smolik
H-270 Morphological aspects of growth, quality, and stress endurance of forage crops; Kephart, Boe, Twidwell
H-279 Ecology and control of western and northern corn rootworm in South Dakota; Fuller, Boetel
H-280 Environmental and biological stress in wheat; Gellner
R-287 Seed production or breeding lines of insect-pollinated forage legumes; Boe
H-309 Oilseed breeding and genetics; Grady
H-320 Reduced tillage crop rotation systems; Stymiest, Geise, Gellner
H-330 Genetics of host-pathogen interactions on row crops in South Dakota; Chase
H-341 Isolation and uses of actinomycetes associated with roots of grasses; Bleakley, Rickerl, T. Schumacher
H-380 Fertilizer nitrogen management of wheat under soil moisture stress; Woodard
H-388 Biological control of insects affecting seed production of forage legumes and grasses; McDaniel
R-398 Forage characterization and utilization for beef cattle; Kephart
R-400 Biological and ecological basis for weed model to reduce herbicide use in corn; S. Clay
S-401 Foundation Seed Stock; Ingemansen
S-402 Seed certification; Pollmann
S-403 Seed testing; Turnipseed
S-404 Variety testing; Bonnemann
S-406 Survey entomologist; Fuller
R-410 Nutrient management to sustain productivity while protecting surface and ground water quality; Gelderman

Rural Sociology

H-167 Census Data Center; Satterlee

Station Biochemistry

H-099 Mineral nutrition and metabolism in animals; Emerick, Kayongo-Male, Pritchard
H-110 Flow cytometry; Evenson
H-149 Analysis of selected herbicides and fungal metabolism; Matthees
H-171 Corn-based fungal polysaccharide production; West
H-209 Biochemistry of selenium; Palmer, Olson
S-407 Analytical services; Thiex

Veterinary Science

AH-121 Epithelioid cell cultures from the small intestine of fetal pigs; Nietfeld, Gates, Brevik
AH-131 Epidemiology and control of johne's disease in South Dakota livestock; Johnson, Fawcett, Bjordahl
AH-159 Characterization of the virulence capacities of enterohemorrhagic excherichia coli of serogroup 0111; Francis
AH-238 BVD in herd health; Thomson
R-281 Bovine respiratory disease: risk factors, pathogens, diagnosis, and management; Miskimins, Thomson, Leslie-Steen
H-300 Bacterial toxins and leukocytes in activation and regulation of porcine lymphocytes; Hurley
H-331 Survey to assess the prevalence of Cache Valley virus and bovine parvovirus in cases of abortion; Yaeger, Nietfeld, Leslie-Steen
R-347 Prevention and control of enteric diseases of swine; Francis, Benfield, Janke
AH-360 Identification and characterization of cellular receptors to bovine coronavirus; Benfield, Nelson

Wildlife and Fisheries Sciences

H-019 Population dynamics of centrarchid bass and panfish in South Dakota ponds; Willis
H-048 Big game use of agricultural cropland and crop depredation patterns in South Dakota; Jenks
MS-051 Wood ducks and prairie woodlands: artificial nesting structures, brood survival, and habitat in South Dakota; Flake
H-071 Northern pike management in South Dakota ponds and small lakes; Scalet
S-492 South Dakota Cooperative Fish and Wildlife Research Unit; Berry, Higgins

Articles, publications

If you are interested in any of these articles or publications and cannot reach the author listed, contact the department under which the reference appears. Some of the authors may be graduate students who have completed their studies and left SDSU. The department will be able to assist you.

Agricultural Engineering

Journal articles:

Alcock, R. and V. Witting. 1991. An empirical method of predicting traction. J of Terramechanics (in press).
Beck, D.L. and D.W. DeBoer. 1992. Post-emergence, interrow tillage to enhance infiltration under sprinkler irrigation. Soil Tillage Res 23:111-123.
Chu, S.T., M.H. Bagherzadeh, D.W. DeBoer, and A. Toghiani-Pozveh. 1992. Evaluation of trail tube irrigation technology. Applied Engineering in Ag 8(1):41.
Chu, S.T. and H.M. Bagherzadeh. 1992. Constant hole spacing trail tubes. J Irrigation and Drainage Engineers 118(10):166.
DeBoer, D.W. and D.L. Beck. 1991. Conservation tillage on a silt loam soil with reduced pressure sprinkler irrigation. Applied Engineering in Ag 7(5):557.
Finney, J.A. and D.W. DeBoer. 1991. Normal and lognormal distributions as models for annual precipitation in South Dakota. South Dakota Acad Sci 70:167.
Froehlich, D.P. and B.J. Glawe. 1991. Parametric analysis of horizontal earth loops. Trans ASME, JSEE 113(2):70.

Froehlich, D.P. and S.H. Pohl. 1991. Strategies toward assuring proper air conditions and animal environments within livestock facilities. ASHRAE symposium: Indoor enviroments on animal health, ASHRAE Trans, ASHRAE.
Schumacher, J.A. and D.P. Froehlich. 1991. Computer controlled chemical application in controlled fields. Trans SAE, J of Commercial Vehicles (in press).

Publications, reports:
Anderson, M.P., S.H. Pohl, and D.P. Froehlich. 1991. Revamping ventilators. Farm Industry News 24(8):36.
Chu, S.T. 1991. Modeling porous media flow moving through water table. ASAE Paper 91-2550.
Chu, S.T. 1992. Soil macropore infiltration model. ASAE Paper 92-2006.
DeBoer, D.W., D.L. Beck, K.A. Stange, and A.R. Bender. 1991. Field evaluation of reduced pressure sprinklers. ASAE Paper MNSK91-102.
DeBoer, D.W., R.A. Kohl, and D.L. Beck. 1991. Performance characteristics of reduced pressure sprinklers. 12th Tech Conf of ICID.
DeBoer, D.W., D.L. Beck, and H.D. Werner. 1991. Will it wash? SDCES FS 866.
Froehlich, D.P., J.L. Julson, and R.J. Derickson. 1991. Easy way to lose money: clean the bin, store the grain, and walk away. SD F&HR 42(2).
Froehlich, D.P., *et al*. 1991. Laptop computer is the brains to a single system that alters chemical rate on-the-go. Successful Farming, April:22.
Julson, J.L., T.P. West, P.G. Krishnan, K. Klemme, and D.C. Swift. 1992. laboratory study of microorganism specific degradation of polyethylene corn starch film. Proc Corn Utilization Conf IV:Paper 52.
Julson, J.L., P.G. Krishnan, M.A. Hanna, R. Chinnaswamy, and S. Sharma. 1992. Characterization of corn flour/polystyrene foam plastics. Proc Corn Utilization Conference IV: Paper 53.
Klemme, K.A., *et al*. 1991. Computes control chemical choices. Soybean Digest (Jan 92 issue).
Krishnan, P.G., Y.V. Pathak, and J.L. Julson. 1992. Erodibility and in vitro dye release from starch polyethylene extrusion products. Am Assoc of Pharmaceutical Sci (in press) (abstr).
Krishnan, P.G., J.L. Julson, T.P. West, and W.J. Park. 1992. Investigation of a common solvent system for the measurement of starch in starch-polyethylene films and starch-polystyrene foam extrudates. Proc Corn Utilization Conference IV: Paper 44.
Zhu, J., R. Alcock, and D. Hettiaratchi. 1991. Development of a root growth monitoring instrument and the study of force effects on root growth. ASAE Paper 91-100.

Animal and Range Sciences

Journal articles:
Freking, B.A. and D.M. Marshall. 1992. Interrelationships of heifer milk production and other biological traits with production efficiency to weaning. J Anim Sci 70(3):646.
McFarland, D.C. 1992. Cell culture as a tool for the study of poultry skeletal muscle development. J Nutr 122:818.
McFarland, D.C., J.E. Pesall, K.K. Gilkerson, and N.H. Ferrin. 1991. Comparison of the proliferation and differentiation of myogenic satellite cells and embryonic myoblasts derived from the turkey. Comp Biochem Physiol 100A(2):439.
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Budget

Agricultural Experiment Station
For July 1, 1991, to June 30, 1992

State appropriation	$5,811,870 *
Federal appropriation	$2,445,790 **
Federal restricted	$1,778,595
Other restricted	$4,692,747
Total	$14,729,002

* Includes $12,898 in one-time dollars
**Federal FY 92

College of Agriculture and Biological Sciences
Agricultural Experiment Station
South Dakota State University
Brookings, SD 57007
R.A. Moore, Director

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Calendar of Events

Date	Event	Person to Contact
November		
	District Weed Meetings	Leon Wrage, Weed Specialist, SDSU
2	District 2--Plankinton	
4	District 4--Onida	
5	District 6--Wall	
6	District 2--Menno or Freeman	
10	District 1--Sisseton	
4-6	South Dakota Rural Health Conference, Sioux Falls	Carolyn Clague, 4-H Youth Specialist
5-6	South Dakota Sheep Growers Annual Convention, Pierre	Jeff Held, Sheep Specialist, SDSU
	Crop Improvement Association District Meetings	Bob Pollman, Crop Improvement Association
16	Northeast District, Webster	
17	North Central District, Ipswich	
18	Northwest District, Bison	
19	Southwest District, Wall	
20	South Central District, Presho	
23	Southeast District, Freeman	
24	Central District, Chamberlain	
25	East Central District, Madison	
17-19	Senior Health Insurance Information and Education Training, Pierre	Bernadine Enevoldsen, Family Finance Specialist, SDSU
19-20	South Dakota Dietetic Association Convention, Pierre	Carol Pitts, Nutrition Specialist, SDSU
December		
	Area Swine Days	Bob Thaler, Swine Specialist, SDSU
Nov. 30	Milbank	
Dec. 1	Howard	
2	Yankton	
3	Sioux Falls	
4	Aberdeen	
5	Wall	
2-3	Cattlemen's Association Convention, Sioux Falls	Don Boggs, Beef Specialist, SDSU
January		
5	South Dakota Seed Trade Association	Bob Hall, Plant Science Specialist, SDSU
	Commercial Applicator's Recertification Training	Jim Wilson Plant Science Specialist, SDSU
19	Yankton	
20	Sioux Falls	
21	Watertown	
25	Mitchell	
26	Rapid City	
27	Pierre	
28	Aberdeen	
26-27	Regional No-Till/Ridge Till Conference, Sioux Falls	Fred Shubeck, Southeast Farm, Beresford
27	South Dakota Homemakers Legislative Day, Pierre	Carletta Kilian, Pierre
29-Feb 7	Black Hills Stock Show, Rapid City	